GEOLOGIC RESOURCE MONITORING PARAMETERS

Coral Chemistry and Growth Patterns

Brief Description: Corals can be used to monitor environmental changes in the oceans and nearby coastal zone. The health, diversity and extent of corals, and the geochemical makeup of their skeletons, record a variety of changes in the ocean surface water. These include temperature (δ18O, Sr/Ca, U/Ca, growth patterns), salinity (δ18O, U/Ca), fertility (Ba/Ca, Cd/Ca), insolation (δ13C, growth patterns), precipitation (δ18O, Sr/Ca, U/Ca), winds (Mn/Ca), sea levels (micro-atoll growth patterns), storm incidence (age of reef of tilted or toppled corals), river runoff (diversity and mortality, fluorescence, trace elements such as Ba), and human inputs (radionuclides, P, heavy metals such as Pb, Cd). Corals in coastal waters are susceptible to rapid changes in salinity and suspended matter concentrations and may be valuable indicators of the marine dispersion of agricultural, urban, mining and industrial pollutants through river systems, as well as the history of contamination from coastal settlements.

Significance: The combination of abundant geochemical tracers, sub-annual time resolution, near-perfect dating capacity, and applicability to both current and past climatic changes establishes corals as one of the richest natural environmental recorders and archives. A 30 cm-diameter coral colony growing at an average rate of 1 cm/yr will provide 20-25 years of baseline data, whereas massive colonies 3-6 m high may provide historical data for extensive tracts of tropical ocean, such as are not otherwise available.

Environment Where Applicable: Tropical oceans and coastal regions between latitudes 25oN and 25oS and warmer than 18oC.

Types of Monitoring Sites: Coral reefs

Method Of Measurement: Analysis of samples from outer (younger) or inner (older) growth layers, though standardized chemical and isotopic, image analyzing, and fluorescence techniques are not yet available for most applications.

Frequency Of Measurement: Annually or longer, depending on the record sought.

Limitations Of Data And Monitoring: The complexity of environmental correlations requires very careful sampling and a high degree of analytical expertise.

Possible Thresholds: Corals can be stressed to the point of bleaching and/or death when ambient conditions (temperature, salinity, turbidity, predation, etc.) change too quickly, or persist too long. Threshold values are difficult to quantify, particularly when more than one property is changing, and may vary from site to site as a consequence of reef adaptation to local conditions. The timing of growth hiatuses within living colonies and of mass mortality events can, however, be useful in inferring past severe and catastrophic disturbances.

Key References:

Dunbar, R.B. & J.E. Cole 1993. Coral records of ocean-atmosphere variability. Report from the Workshop on Coral Paleoclimate Reconstruction, NOAA Climate and Global Change Program, La Parguera, Puerto Rico, Nov. 5-8, 1992.

Pernetta, J.C. (ed) 1993. Monitoring coral reefs for global change. Cambridge, International Union for the Conservation of Nature.

Shen, G. 1996. Rapid change in the tropical ocean and the use of corals as monitoring systems. In Berger, A.R. & W.J.Iams (eds). Geoindicators: Assessing rapid environmental changes in earth systems:141-146. Rotterdam: A.A. Balkema.

Related Environmental And Geological Issues: Corals may provide useful means of monitoring the dispersal of river sediments and pollution in coastal areas. Environmental threats to living coral reefs are widespread, and there is a considerable body of knowledge devoted to monitoring reefs in order to protect and conserve them.

Overall Assessment: Corals constitute a very effective recorder and a rich natural archive of environmental change.

Source: This summary of monitoring parameters has been adapted from the Geoindicator Checklist developed by the International Union of Geological Sciences through its Commission on Geological Sciences for Environmental Planning. Geoindicators include 27 earth system processes and phenomena that are liable to change in less than a century in magnitude, direction, or rate to an extent that may be significant for environmental sustainability and ecological health. Geoindicators were developed as tools to assist in integrated assessments of natural environments and ecosystems, as well as for state-of-the-environment reporting. Some general references useful for many geoindicators are listed here:

Berger, A.R. & W.J.Iams (eds.) 1996. Geoindicators: assessing rapid environmental change in earth systems. Rotterdam: Balkema. The scientific and policy background to geoindicators, including the first formal publication of the geoindicator checklist.

Goudie, A. 1990. Geomorphological techniques. Second Edition. London: Allen & Unwin. A comprehensive review of techniques that have been employed in studies of drainage basins, rivers, hillslopes, glaciers and other landforms.

Gregory, K.J. & D.E.Walling (eds) 1987. Human activity and environmental processes. New York: John Wiley. Precipitation; hydrological, coastal and ocean processes; lacustrine systems; slopes and weathering; river channels; permafrost; land subsidence; soil profiles, erosion and conservation; impacts on vegetation and animals; desertification.

Nuhfer, E.B., R.J.Proctor & P.H.Moser 1993. The citizens' guide to geologic hazards. American Institute for Professional Geologists (7828 Vance Drive, Ste 103, Arvada CO 80003, USA). A very useful summary of a wide range of natural hazards.